# Hypoxia effects on Hemigrapsus oregonensis

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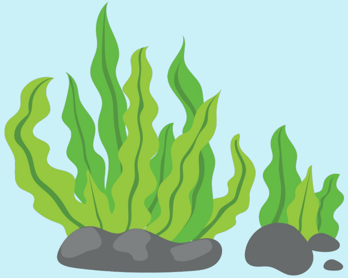


## Background:

# How are hypoxic water masses forming and how will it affect crab fisheries?

# Background

## Climate Change and Hypoxic Water Masses

### Water Transport

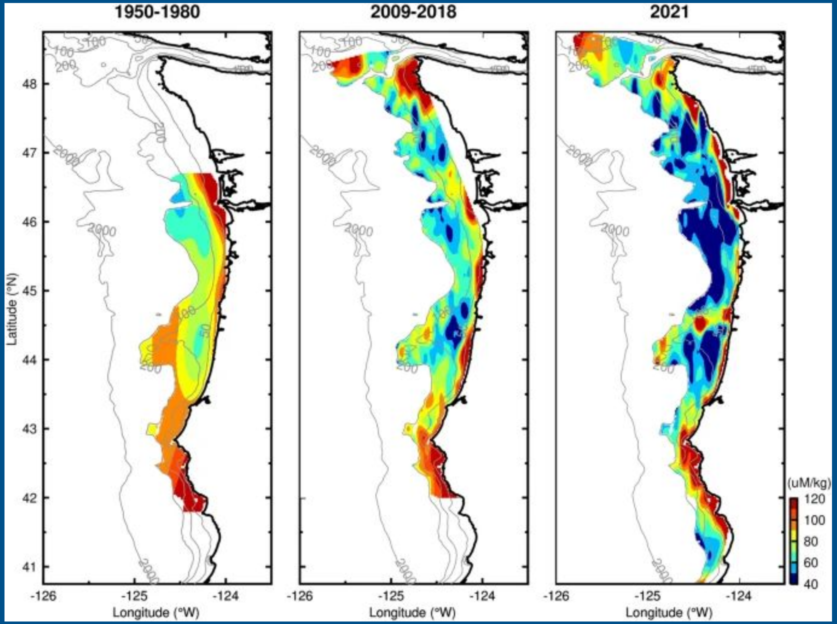
- Increasing with changing wind and temperature regimes
- Creates a seasonal pattern of hypoxic conditions

### Eutrophication

- Driven by rising temperatures and nutrient runoff
- Lead to massive respiration-photosynthesis imbalances

# Water Transport

## Upwelling

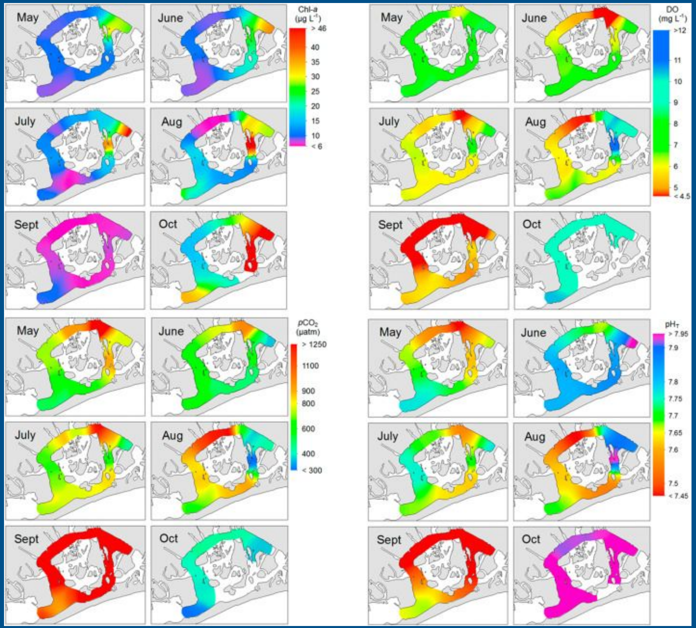



- Wind changes are occurring due to evolving land-sea temperature differences
- Spring-summer transportation of cold, hypoxic water to shallower coastal habitats
- Fraction of transported water that is hypoxic has increased dramatically in the last 70 years

Barth et al, 2024

# Eutrophication

## Algal Blooms



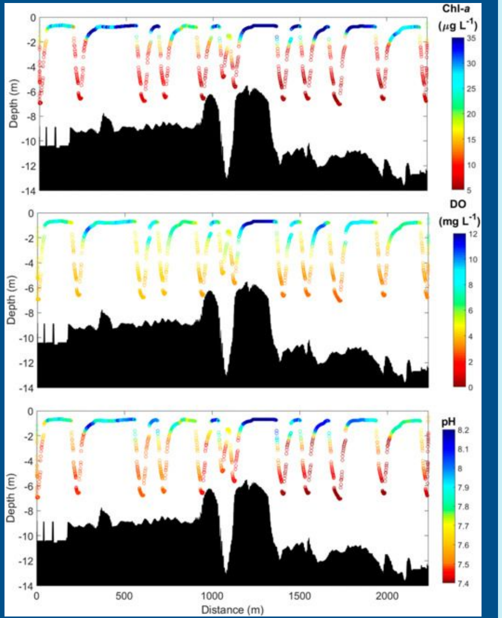

- Algal blooms form as temperatures rise during the spring
- Raised nutrient concentrations due to runoff fuel overwhelming growth
- As nutrients are consumed, algae begins to die and decompose

Wallace and Gobler, 2021

# Eutrophication

## Algal Blooms

Continuous Underway Towing Profile




- As algae die, they sink and decompose
- Decomposition consumes oxygen and leads to lower concentrations of DO at depth even as DO remains high at the surface

Wallace and Gobler, 2021

# Background

## Implications of Climate Change to Crabs

### Stress Physiology

- Hypoxic environments leading to change in crab behavior
- Application to other marine invertebrates

### Commercial Crab Industry

- Impacts to commercial crab industries
- Decline in revenue and job opportunities

# Stress Physiology

## What can be tested

- **Effects on respiration**
  - **Lactate** - shift to anaerobic metabolism causes increased lactate production in the hemolymph
  - **Respirometry with Resazurin** - blue dye that when exposed to metabolically active cells reduces it to resorufin (becomes pink) by consuming oxygen; faster the change in color → more oxygen consumption, would expect a slower consumption
- **Energy**
  - **Glucose** - can show signs of change in metabolic rate, feeding, and energy costs from adjusting to environment
  - **Triglyceride** - the stored lipids in crabs can show energy reserve, the building or depletion of fat stores, can indicate if stressors are causing energy depletion

# Stress Physiology

**What can be tested**

- **Other signs of stress / impacts from hypoxia**
  - **BCA Protein** - low levels of hemolymph protein levels can indicate chronic stress / metabolic depletion; under stress they can begin to break down proteins for more energy
  - **Righting Test** - Can indicate the energetic ability of the individual (do they have the energy to flip themselves back over)
  - **Gill Tissue Wasting** - Atrophic gill filaments or deteriorated gill filaments is a common result of prolonged hypoxia exposure
  - **Death** - strong indicator that the conditions led to high stress and physiological changes

# Commercial Crab Industry

**Threats to the commercial crab industry due to climate change**

- **Sudden increase in hypoxic conditions leading to crab decliens**
    - Instances of severe hypoxic conditions from harmful algal blooms has significantly increased in the last few decades and impacts commercial fisheries abilities to catch crabs / enough
- **Poor management to counteract impacts**
    - Many fisheries do not have the management in place to combat these declines
    - Need to find the balance between working with those relying on crabbing for their livelihood and researchers which can prolong implementation of  management
- **Overall revenue decline**
    - Loss of crab abundance leads to overall revenue loss, impacting companies and individuals who rely on crabbing

# Experimental Design

## Control Tank

**Control Tank:**

- High DO2 from air stone
- 13 °C
- 35 ppt salinity
- Plastic rocks for cover
- No access to air

**Controlled Variables Across Treatments:**

- Temperature
- Salinity
- Plastic rocks for cover

# Experimental Design

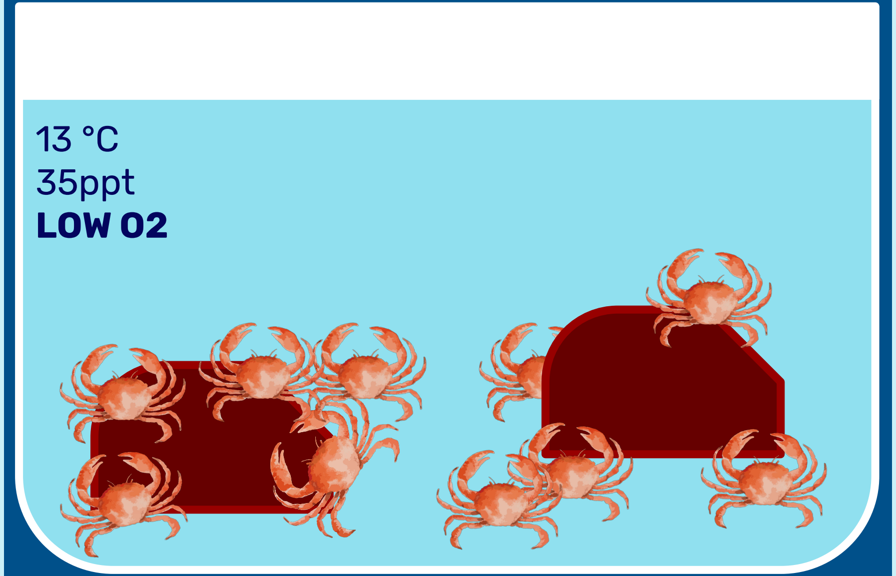
## Manipulated variables

**Tank 1**

- **Same temp, salinity, and cover as control**
- **10 crabs**

**Manipulated Variable:**

- **No air stone ↦ low DO2**



# Experimental Design

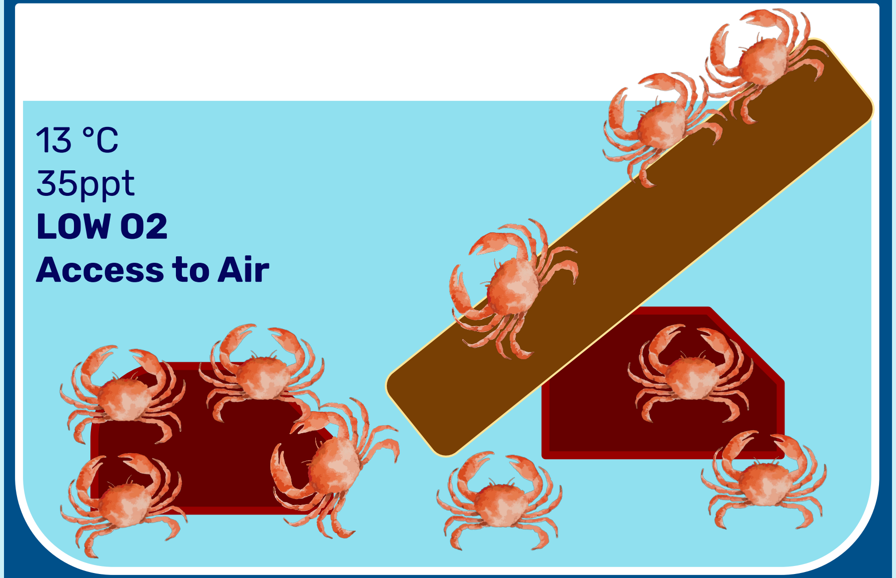
## Manipulated variables

**Tank 2**

- **Same temp, salinity, and cover as control**
- **10 crabs**

**Manipulated Variables:**

- **No air stone ↦ low DO2**
- **Access to air**



# Experimental Design

## Experimental Timeline

### After One Week in Tanks:

- ½ of crabs given non-lethal stress tests.
- Tested crabs marked with nail-polish and returned to tanks.

### Non-Lethal Stress Tests:

- Respiration ↦ resazurin
- Lethargy ↦ self-righting speed

# Experimental Design

## Experimental Timeline

### After Two Weeks in Tanks:

- All crabs given non-lethal stress tests.
- All crabs given lethal stress tests.

### Lethal Stress Tests:

- Gill tissue wasting (dissection)
- Hemolymph Content
  - Glucose
  - Triglyceride

## Research Question:

# How will hypoxia affect the physiology of hairy shore crabs?

# Hypotheses:

Crabs with access to air will leave the water to escape the hypoxic conditions and resulting stress.

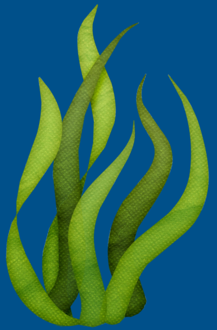
Crabs experiencing hypoxia for at least a week will be lethargic and may not be able to right themselves.

Crabs may die from long-term exposure to hypoxic water.

Crabs will switch to anaerobic metabolism and lactate in the hemolymph will increase. Hypoglycemia may occur.

Energy-consumption will increase as heightened stress levels cause fat stores to be depleted.

Gill tissues will deteriorate and BCA levels will be low in the hemolymph.



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# Thank You for Listening,
# Any Questions?